Production of multi-charged phosphorus ions with ecris 'SUPERSHyPIE' at GANIL

J.Y. Pacquet, R. Leroy, L. Maunoury, C. Barué, C. Canet, M. Dubois, M. Dupuis, F. Durantel, J.L. Flambard, G. Gaubert, et al.

november 2003

Production of multi-charged phosphorus ions with ecris "SUPERSHyPIE" at GANIL

J-Y. Pacquet, R. Leroy, L. Maunoury**, C. Barué, C. Canet, M. Dubois, M. Dupuis, F. Durantel, J-L. Flambard, G. Gaubert, C. Huet-Equilbec, P. Jardin, S. Kantas*, N. Lecesne, P. Lehérissier, F. Lemagnen, M.G. Saint-Laurent, O. Tuske and A.C.C Villari

GANIL, B.P. 5027, 14076 Caen Cedex 05, France
* PANTECHNIK, 12, rue Alfred Kastler, 14000 Caen, France
** CIRIL, B.P. 5133, 14070 Caen Cedex 05, France

1- Introduction

The Ganil's Ion Production Group tested the source SUPERSHyPIE[123] for the production of phosphorus n+ ion beams. The SUPERSHyPIE ecris is used for many tests of multi-charged ion production and supply ion beams for LIMBE[4] (low energie beam line). This ion source works with a 14.5ghz RF power injected by a circular waveguide in the axis of the source

2- The experiment

An Al_2O_3 container, with an internal diameter of 1,6mm, is used to receive red phosphorus. (the red phosphorus is less dangerous than the white phosphorus). To ensure the production, hydrogen support gas reacts with phosphorus to form volatile molecules[567] witch are dissociated and ionized by the plasma of SUPERSHyPIE. We use the micro-oven developed by Ganil to tune the beam intensity. The micro-oven is situated at 15 mm from the axis and near the maximum of the magnetic field.

3- Operation

During the tests, the extraction voltage was 15kV and the current produced by the source was between 3.3 and 4.6mA. The beam efficiency transport in these conditions is respectively 34 and 25% (ratio between the sum of the pics measured on the faraday cup right behind the analysing magnet and the total extracted current beam).
With an HF power of 210 Watts, the ionization efficiency for phosphorus is about 35% for a P^{7+} intensity contained between 100µAe and 145µAe (170 and 225µAe for the P^{6+} intensity). The sum of the phosphorus peeks in the spectrum behind the analysing magnet (fig1) is about 170µAp (the values of phosphorus 1, 2 et 3^+ are estimated). The total intensity of phosphorus extracted of the source (corrected with the beam efficiency transport average of 34%) is about 500µAp. With the beam efficiency transport of 25%, the ionization efficiency for phosphorus is 47%.

Some production tests showed the dependence of the Phosphorus intensity with the oven heating. The oven temperature isn't precisely known because the contributions on oven heating of the RF power and of the plasma are unknown. When the source is started at 210W RF power and without heating of the oven, the P^{7+} beam current is about 10µAe,. The beam quickly increases with the heating of the oven The necessary time to obtain a stable beam is about a half an hour.

The beam transport efficiency is defined by the ratio between the sum of the peeks in the spectrum and the high voltage current . The source was operated during 16 hours with a P^{7+} average intensity of 115µAe

At the end of this test, the mesurement of phosphorus consumption allow to calculate the phosphorus ionisation efficiency of SUPERSHyPIE under these conditions.

We can also notice the noise on the intensity recording of P^{7+}(fig2). This effect is always present and equals about 4% of total signal. When the heating oven is switch off, the phosphorus beam current quickly decreases of 50% after only 10 minutes.

fig.1

phosphorus spectrum from SUPERSHyPIE

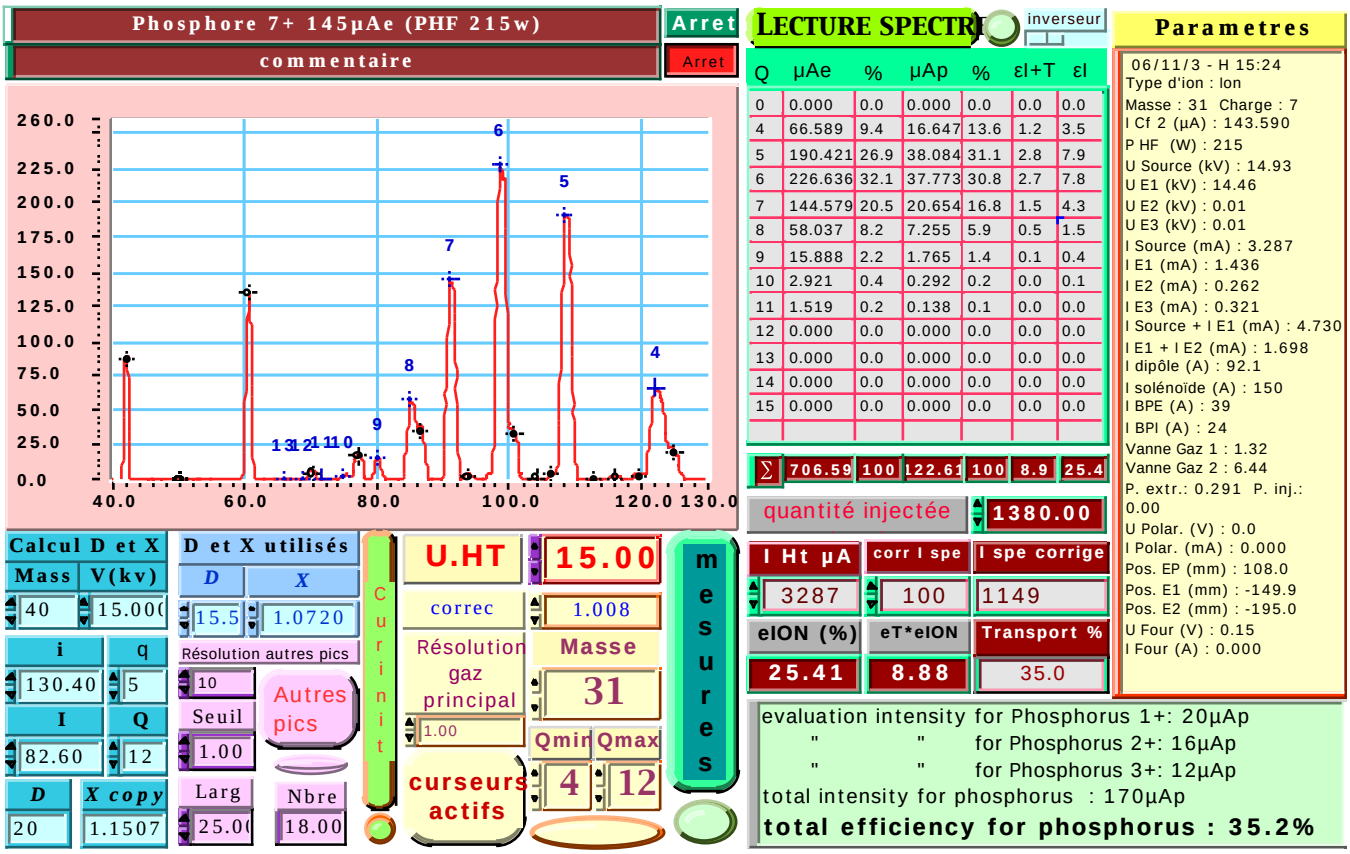
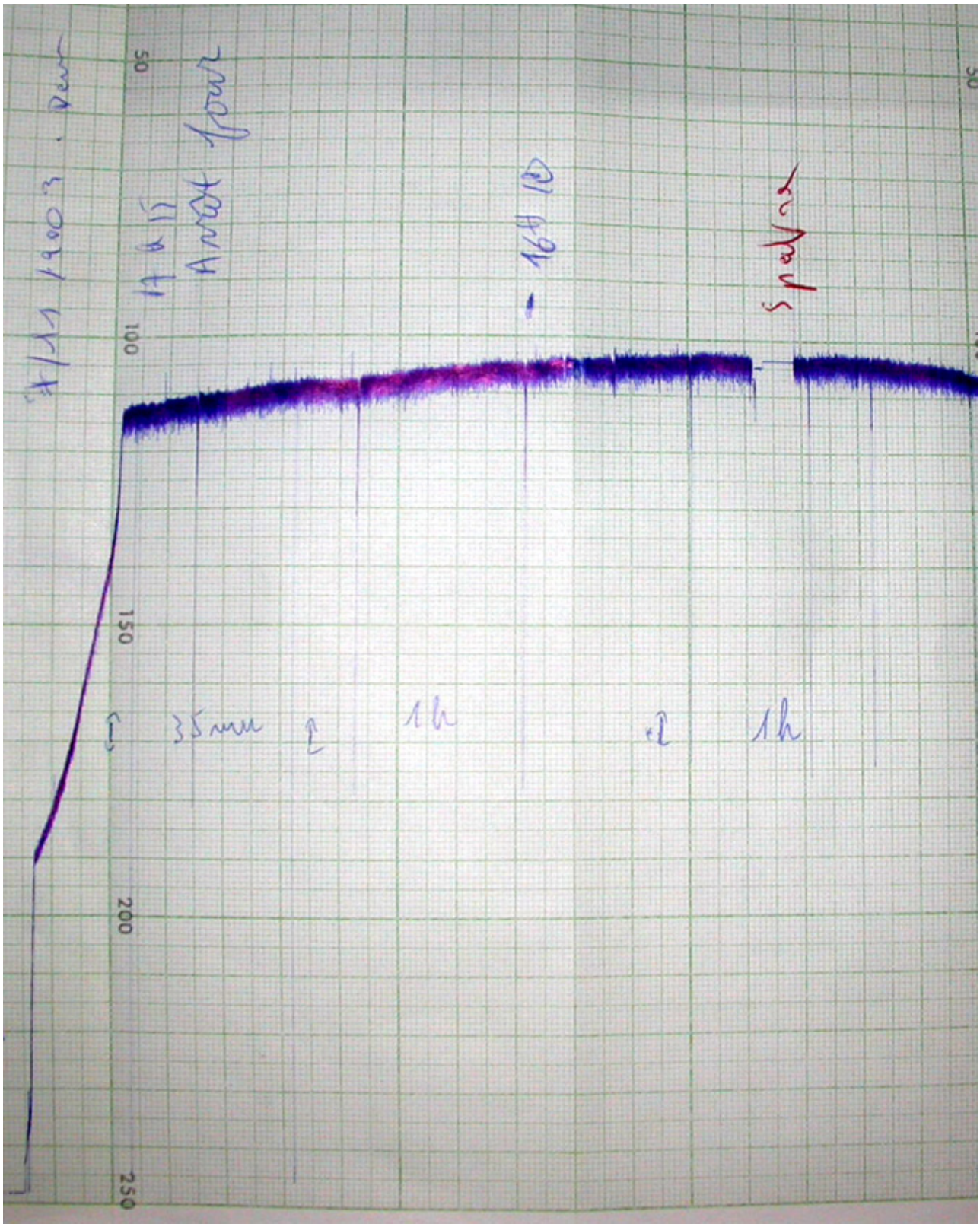


fig.2

recording of ion phosphorus 7+ (140µAe)



References

[1] D. Leclerc and al., Journees Sources d'ions, GANIL, CAEN, Mars 1999

[2] R. Leroy and al., 14th International Workshop on ECR Ion Sources, may 1999

[3] J.Y. Pacquet, R. Leroy, N. Lecesne, P. Sortais, A. Villari, EP Patent N° 97 401294

[4] L. Maunoury et al.,LIMBE: A New Facility for Low Energy Beams, Review of Scientific Instruments ,February 2002,73,2,561

[5] M.-A. Golombeck, S. Heise, K. Schloesser, B. Schuessler, H. Schweickert, Nucl. Inst. Meth B 206 (2003) p 495

[6] P. Fehsenfeld, M. Golombeck, A. Kleinrahm, K. Schloesser, B. Schuessler, H. Schweickert and C. Hehrlein, Semin intervent cardiol 3 (1998) 157

[7] E. Huttel, J. Kaltenbaek, K. Schloesser and H. Schweickert, Rev. of Scientific Inst. 73 (2002) 825